PRECISION ESTIMATES OF AASHTO T 201, AASHTO T 202, and AASHTO T 49

Appendices

Prepared for
National Cooperative Highway Research Program
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APPENDIX A- NEW ANALYSIS METHOD FOR PREPARING PRECISION ESTIMATES USING PROFICIENCY DATA

The method used to analyze the PSP data is explained in Phase3 Report of NCHRP 9-26 study "Precision Estimates for AASHTO Test Method T308 and the Test Methods for Performance-Graded Asphalt Binder in AASHTO Specification M320" [2]. The method is designed to extract the core of the data and then analyze that core for determining within- and between- coefficients of variation (COV). Within- laboratory data are obtained under conditions of the test method using a single operator performing the test with the same equipment over a short period of time. Between- laboratory data are obtained under conditions of the test method using different operators, different laboratories, and different equipment. Before determining precision estimates, the analysis eliminates the null, invalid, and outlying data and identifies the most reliable data from the spread around the median. The four-step AMRL methodology to obtain reliable single-operator and multilaboratory estimates of precision is summarized as follows:

First, null responses and unpaired data are removed. Null responses are the non-responses from laboratories that receive PSP samples but do not submit any testing results. Unpaired data are the partial responses from laboratories that only submit results from one of the two samples. Second, the invalid data are removed. Invalid data are those data points that fall beyond the 4.7 standard deviation from the median. Third, the outlying data are removed. The outlying data are data values that are greater than 2.7 standard deviations from the median after removal of invalid data. In the fourth step, traditional standard deviation-type analyses are performed on the remaining data to determine repeatability and reproducibility precision estimates. Repeatability estimates, s_r, are obtained in the following manner:

$$s_r = \sqrt{\frac{\sum[(x_i - y_i) - (\bar{x} - \bar{y})]^2}{2(n-1)}}$$

Where:

s_r = repeatability estimate
x_i = laboratory test result from X sample of a pair
y_i = laboratory test result from Y sample of a pair
$\bar{x}$ = average of all x_i
$\bar{y}$ = average of all y_i
n = number of laboratories

The equation above removes any actual differences in the X and Y samples and allows the paired test results to be treated as replicates.

Reproducibility estimates, s_{Rx} and s_{Ry}, are obtained independently for each of the two samples by applying the following equations used for determining sample standard deviations:

$$s_{Rx} = \sqrt{\frac{\sum(x_i - \bar{x})^2}{n-1}}$$

$$s_{Ry} = \sqrt{\frac{\sum(y_i - \bar{y})^2}{n-1}}$$

Where:

s_{Rx} = reproducibility estimate for X sample of a pair
s_{Ry} = reproducibility estimate for Y sample of a pair
x_i = laboratory test result from the X sample of a pair
y_i = laboratory test result from the Y sample of a pair
$\bar{x}$ = average of all x_i
$\bar{y}$ = average of all y_i
n = number of laboratories

APPENDIX B- PROFICIENCY SAMPLE INSTRUCTIONS AND DATA SHEETS

AASHTO MATERIALS REFERENCE LABORATORY (AMRL)

Instructions for Testing and Reporting

Viscosity Graded Asphalt Cement Proficiency Samples No. 231 and No. 232

Closing Date April 18, 2013

All tests should be conducted on each of the two samples according to the AASHTO or ASTM Standard Methods indicated. For any tests you do not choose to perform, leave the appropriate spaces on the data sheet blank.

Directions for the individual tests on Samples No. 231(A) and No. 232(B) follow:

Note: The outside of the box is labeled 231(A) and 232(B). The cans inside the box are labeled only (A) or (B). The can labeled (A) is sample 231. The can labeled (B) is sample 232.

For each test performed please report the result of a single determination only, not the average of two or more, except in cases where an average is called for in the method. The program is designed to obtain two independent test results, one for each numbered sample, for each test method that the laboratory chooses to perform.

Penetration of Bituminous Materials at 25°C, T49-07 or D5-06: Report, to the nearest whole unit, the average of three penetrations (at 25°C, 100 g, 5 sec.) whose values do not differ more than the amount given in T49 (D5).

Penetration of Bituminous Materials at 4°C, T49-07 or D5-06: Report, to the nearest whole unit, the average of three penetrations (at 4°C, 200 g, 60 sec.) whose values do not differ by more than the amount given in method T49 (D5).

Flash Point by Cleveland Open Cup, T48-06 or D92-12: Report the flash to the nearest degree Celsius (estimated). Correct the observed value for barometric pressure if necessary. If a skin should form, move it carefully aside with a glass rod or spatula and continue with the determination of the flash point. Please note this condition under “comments” or “feedback” when the results are submitted.

Specific Gravity (Relative Density) of Bituminous Materials, T228-09 or D70-09: Determine the specific gravity (relative density) at 25°C relative to water at 25°C. Report the results to the nearest 0.0001 gravity unit.

Kinematic Viscosity of Asphalts, T201-10 or D2170-10: Report the kinematic viscosity at 135°C in mm^2/s (cSt) to four significant figures.

Viscosity of Asphalts by Vacuum Capillary Viscometer, T202-10 or D2171-10: Report the viscosity, at 60° C and 300 mm Hg vacuum, in Pa·s to four significant figures. (1 Pa·s is equivalent to 10 Poise)

Rolling Thin Film Oven Test (RTFO), T240-09 or D2872-12: Change in Mass:

Weigh the sample and containers to the nearest milligram. Report, to the nearest 0.001 percent, the average change in mass of the material. *Please use a negative number to report a mass loss and a positive number to report a mass gain.*

Penetration of the RTFO Residue at 25°C, T49-07 or D5-06: Report, to the nearest whole unit, the average of three penetrations at 25°C, 100 g, 5 sec., whose values do not differ by more than the amount given in Method T49 (D5).

Penetration of the RTFO Residue at 4°C, T49-07 or D5-06: Report, to the nearest whole unit, the average of three penetrations at 4°C, 200 g, 60 sec., whose values do not differ by more than the amount given in Method T49 (D5).

Kinematic Viscosity of the RTFO Residue at 135°C, T201-10 or D2170-10: Report the kinematic viscosity at 135°C in mm^2/s (cSt) to four significant figures.

Viscosity of the RTFO Residue at 60°C, T202-10 or D2171-10: Report the viscosity of the residue, at 60°C and 300 mm Hg vacuum, in Pa·s to four significant figures. (1 Pa·s is equivalent to 10 Poise)

Viscosity Graded Asphalt Cement Proficiency Sample Data Sheet

Closing Date: April 18, 2013

TESTS ON ASPHALT TYPE: PG 64-22	SAMPLE 231(A)	SAMPLE 232(B)
Penetration of Original Sample: *Select the Box to Show the Method Used* - **T49** ☐, **D5** ☐		
Penetration of Original Sample at 25°C, 100 g, 5 s (nearest unit) .....**(1)**		
Penetration of Original Sample at 4°C, 200 g, 60 s (nearest unit) .....**(2)**		
Flash Point by Cleveland Open Cup: *Select the Box to Show the Method Used* – **T48** ☐, **D92** ☐		
Type of Apparatus - Select the box to Show the Type Used .....Manual ☐, Automated ☐		
Barometric Pressure at the Time of the Test (for informational purposes; no ratings)		
Sample 231(A): _____ (mm of Hg)		
Sample 232(B): _____ (mm of Hg)		
Corrected Flash Point (nearest °C) .....**(3)**		
Specific Gravity (Relative Density): *Select the Box to Show the Method Used* - **T228** ☐, **D70** ☐		
Specific Gravity (Relative Density) at 25/25°C (nearest 0.0001) .....**(4)**		
Kinematic Viscosity: *Select the Box to Show the Method Used* - **T201** ☐, **D2170** ☐		
Kinematic Viscosity of Original Asphalt at 135°C (mm^2/s, to four significant figures) .....**(5)**		
Viscosity by Vacuum Capillary: *Select the Box to Show the Method Used* - **T202** ☐, **D2171** ☐		
Viscosity of Original Asphalt at 60°C (Pa·s, to four significant figures) .....**(6)**		

TESTS ON RESIDUE FROM RTFO (T240 / D2872)	SAMPLE 231(A)	SAMPLE 232(B)
Rolling Thin-Film Oven Testing: *Select the Box to Show the Method Used* – **T240** ☐, **D2872** ☐		
Elevation of Laboratory above Sea Level (in feet) _____ feet		
Average Barometric Pressure at Time of Testing (in mm of Hg) _____ mm of Hg		
Airflow Rate Exiting Air Jet (in mL / min) _____ mL / min		
Average Testing Time in the Oven (in minutes) _____ minutes		
Change in Mass: ***Use a negative number to report a loss.*** (nearest 0.001 percent).....**(7)**		
Penetration of RTFO Residue: *Select the Box to Show the Method Used* - **T49** ☐, **D5** ☐		
Penetration of RTFO Residue at 25°C, 100 g, 5 s (nearest unit) .....**(8)**		
Penetration of RTFO Residue at 4°C, 200 g, 60 s (nearest unit) .....**(9)**		
Kinematic Viscosity: *Select the Box to Show the Method Used* - **T201** ☐, **D2170** ☐		
Kinematic Viscosity of RTFO Residue at 135°C (mm^2/s, to four significant figures) .....**(10)**		
Viscosity by Vacuum Capillary: *Select the Box to Show the Method Used* - **T202** ☐, **D2171** ☐		
Viscosity of RTFO Residue at 60°C (Pa·s, to four significant figures) .....**(11)**		

Please complete the information below to identify your laboratory.

Lab Name:		**Lab Number:**	
City, State:			
Country:			
Tested By:			
Lab Phone:			

Comments:

APPENDIX C- GRAPHS OF T 201 PROFICIENCY SAMPLE DATA

Kinematic Viscosity of Original Asphalts (T201)

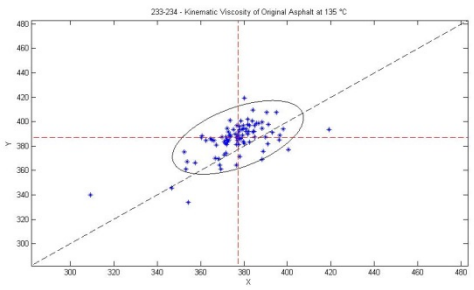


Figure B-1- PSP Sample 233-234

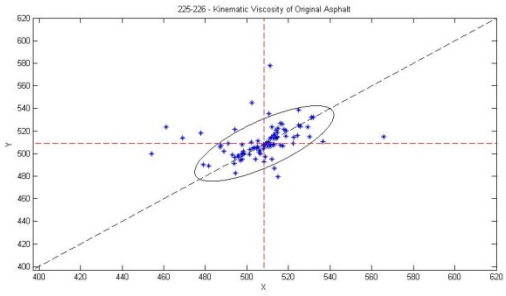


Figure B-5- PSP Sample 225-226

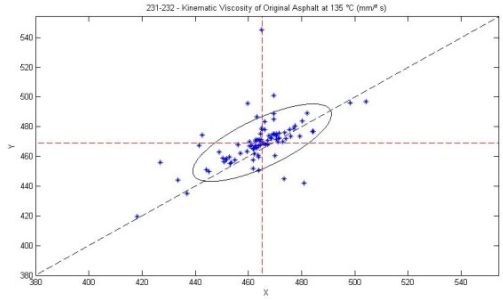


Figure B-2- PSP Sample 231-232

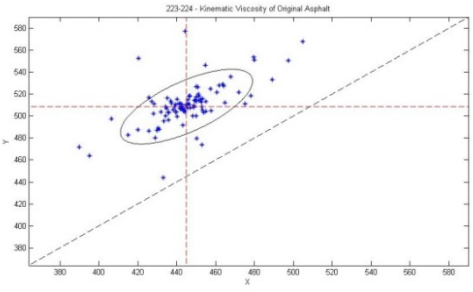
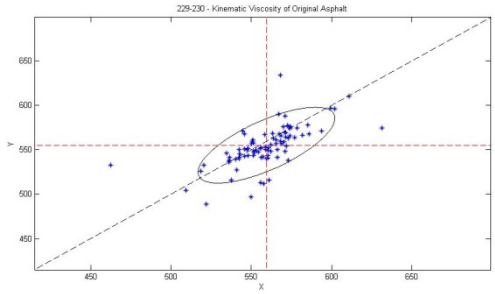


Figure B-6- PSP Sample 223-224



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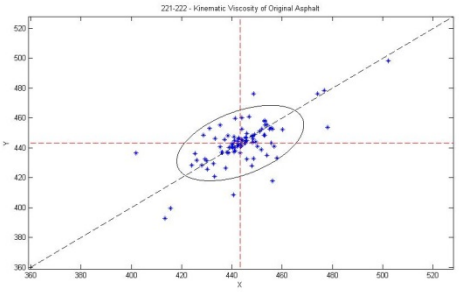

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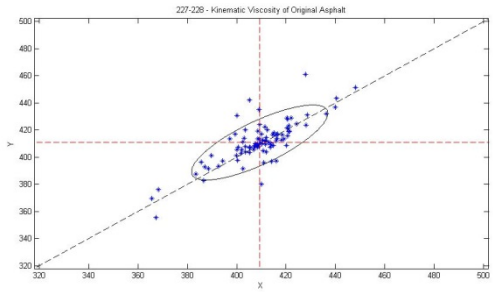

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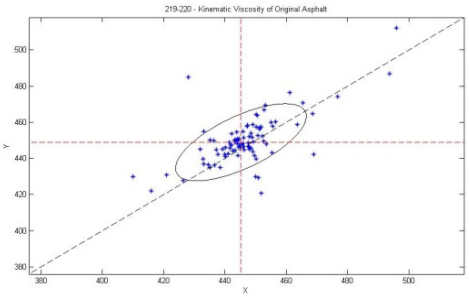
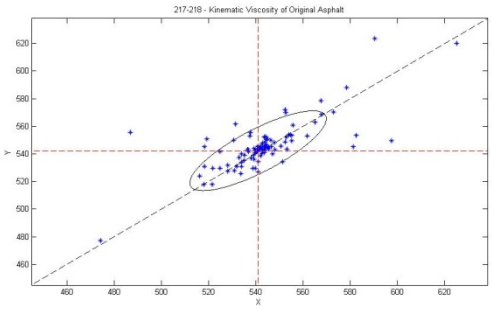


Figure B-8- PSP Sample 219-220



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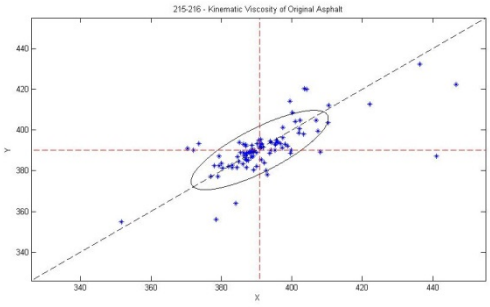

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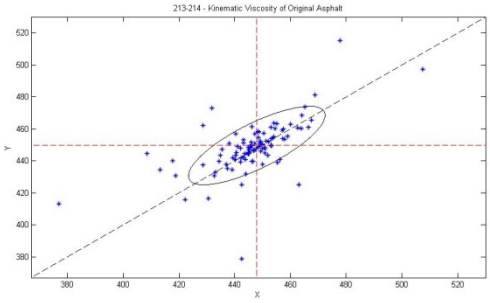


Figure B-11- PSP Sample 213-214

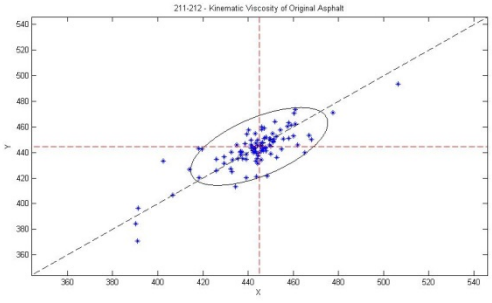


Figure B-12- PSP Sample 211-212

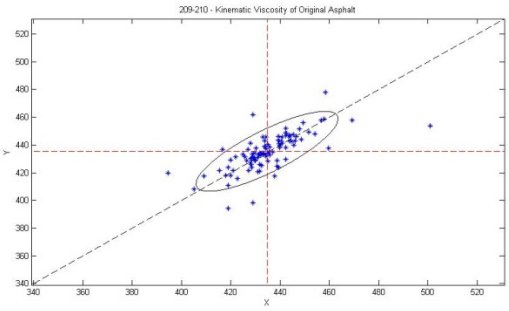
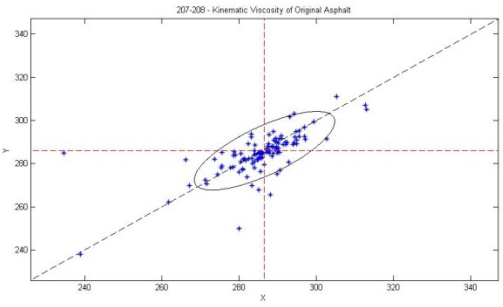


Figure B-13- PSP Sample 209-210



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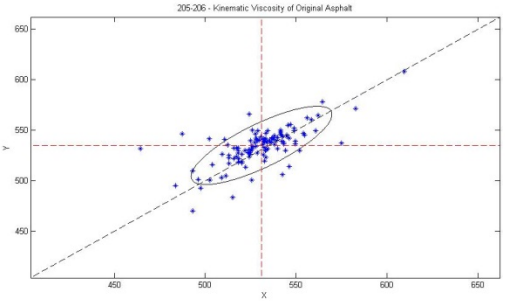

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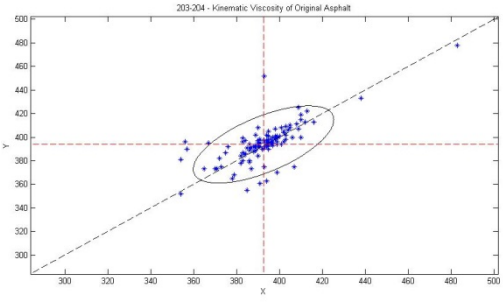

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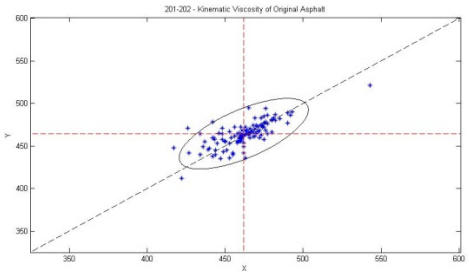

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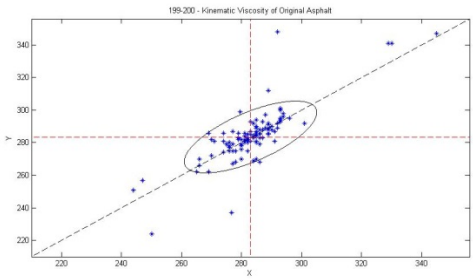

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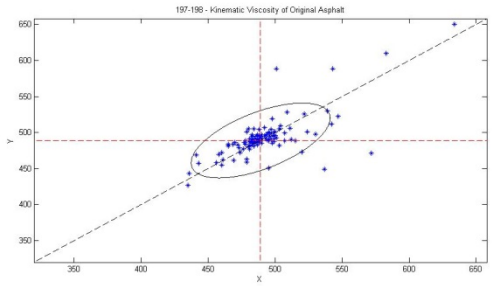

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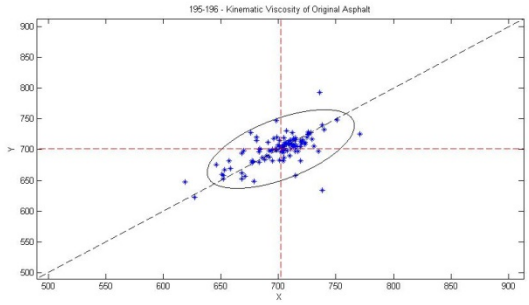

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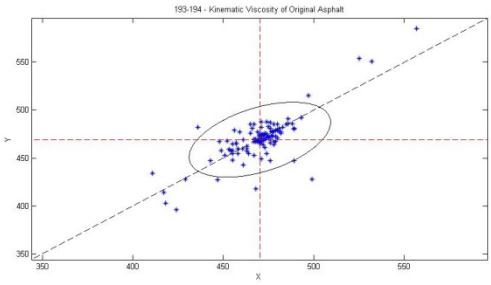


Figure B-21- PSP Sample 193-194

Kinematic Viscosity of RTFO Asphalts (T201)

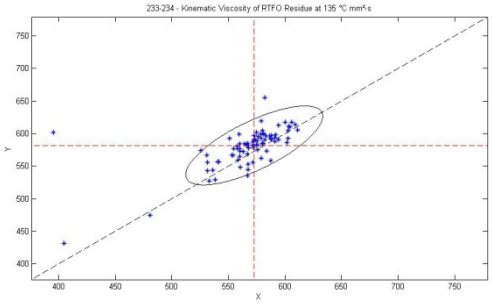
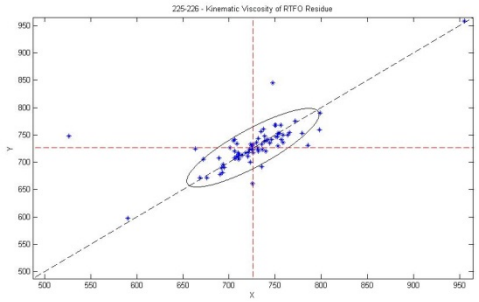


Figure B-22- PSP Sample 233-234



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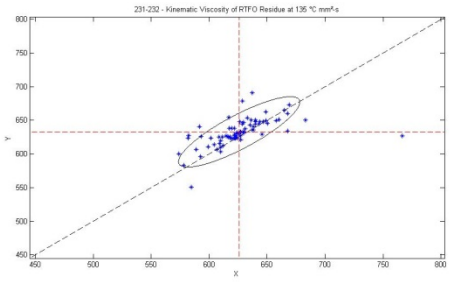


Figure B-23- PSP Sample 231-232

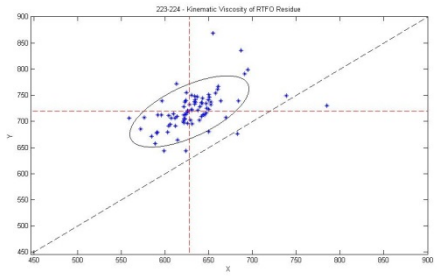


Figure B-27- PSP Sample 223-224

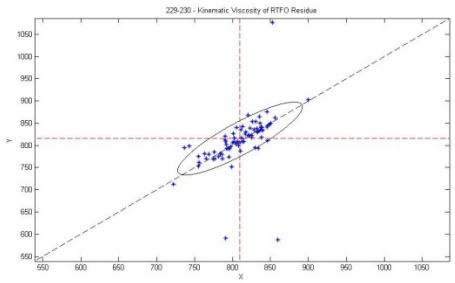


Figure B-24- PSP Sample 229-230

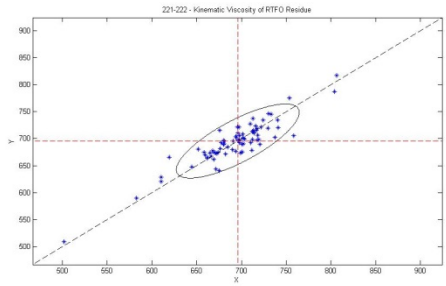
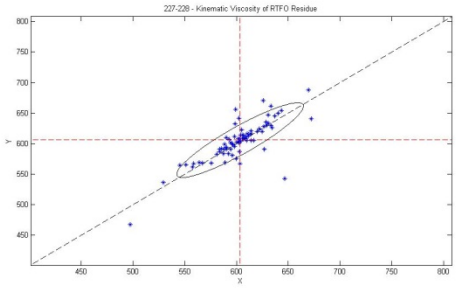


Figure B-28- PSP Sample 221-222



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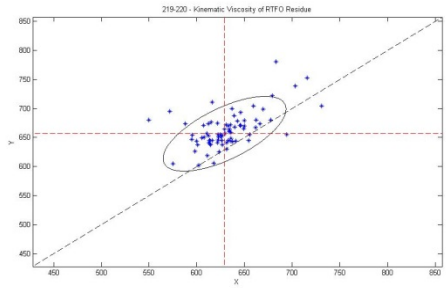

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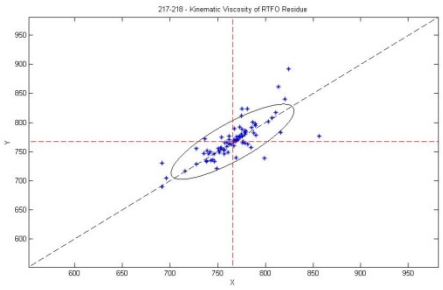
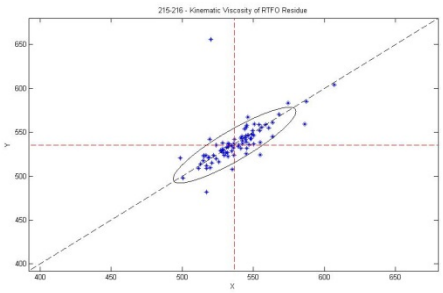


Figure B-30- PSP Sample 217-218



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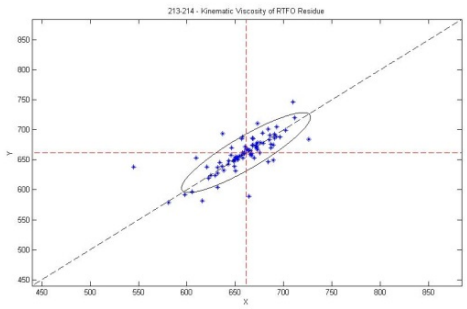
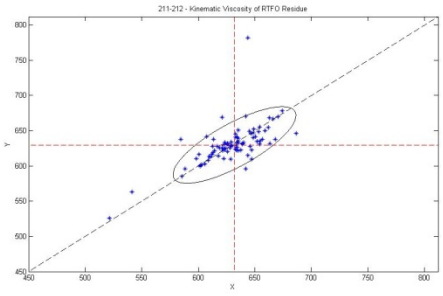


Figure B-32- PSP Sample 213-214



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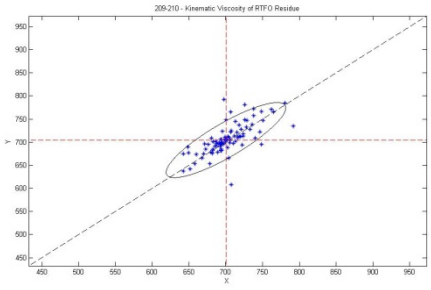

Figure B-34- PSP Sample 209-210

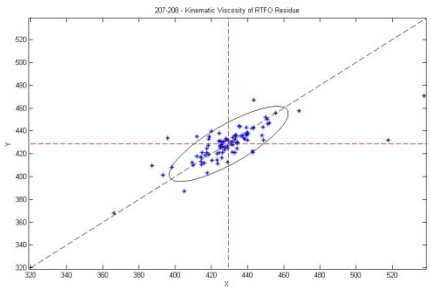

Figure B-35- PSP Sample 207-208

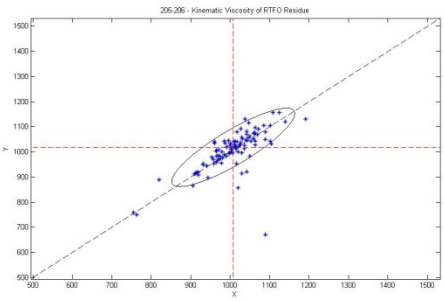

Figure B-36- PSP Sample 205-206

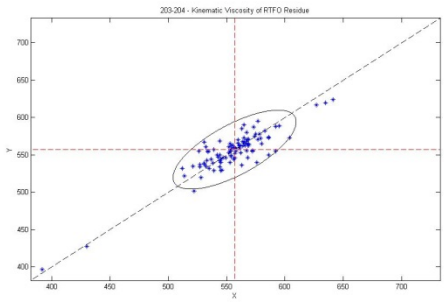

Figure B-37- PSP Sample 203-204

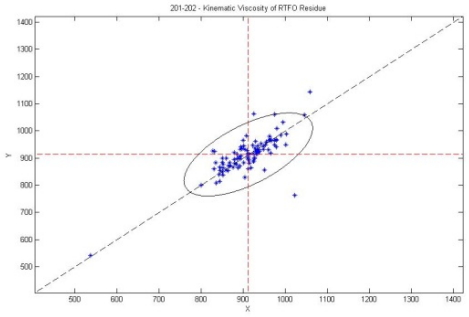

Figure B-38- PSP Sample 201-202

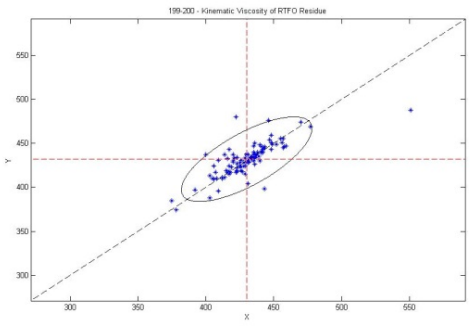

Figure B-39- PSP Sample 199-200

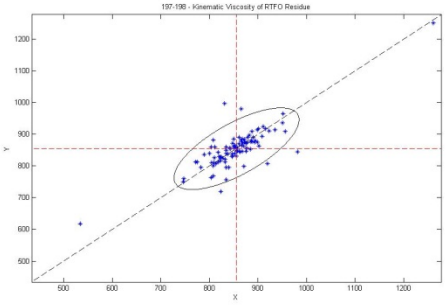

Figure B-40- PSP Sample 197-198

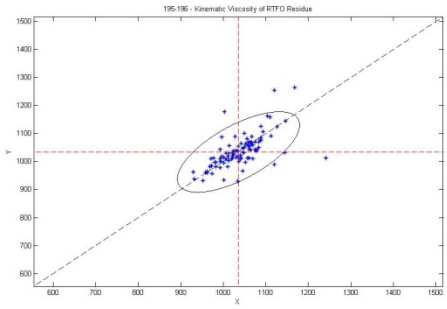

Figure B-41- PSP Sample 195-196

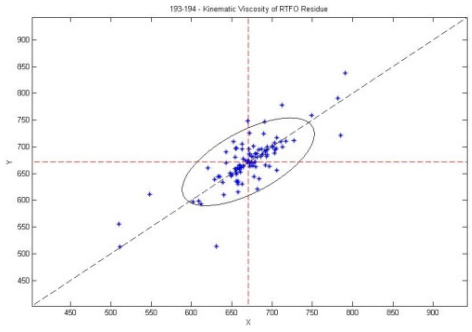

Figure B-42- PSP Sample 193-194

APPENDIX D- GRAPHS OF T 202 PROFICIENCY SAMPLE DATA

Viscosity of Original Asphalt Binder (T202)

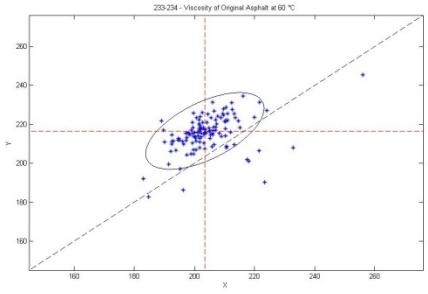

Figure C-1- PSP Sample 233-234

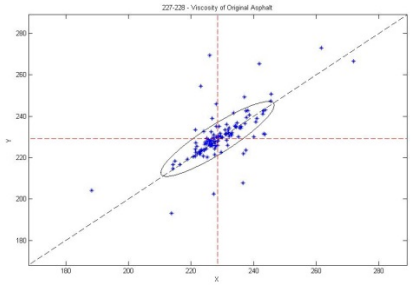

Figure C-4- PSP Sample 227-228

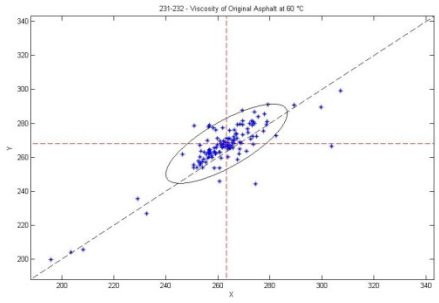

Figure C-2- PSP Sample 231-232

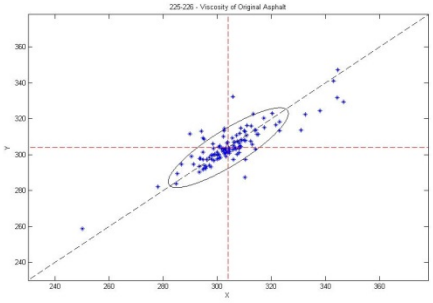

Figure C-5- PSP Sample 225-226

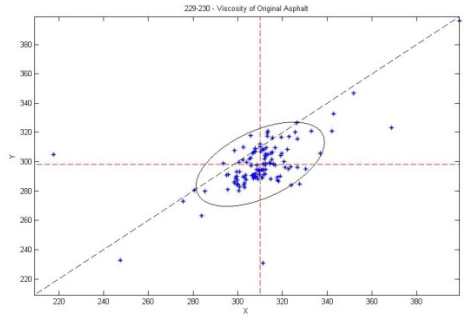

Figure C-3- PSP Sample 229-230

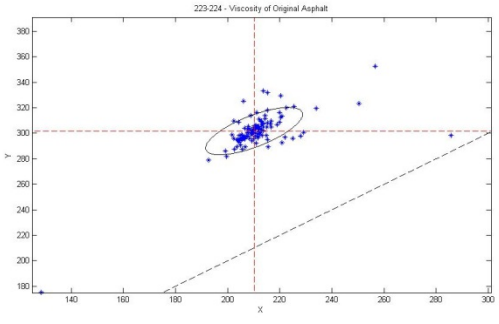

Figure C-6- PSP Sample 223-224

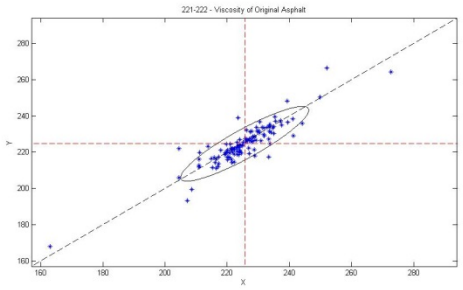

Figure C-7- PSP Sample 221-222

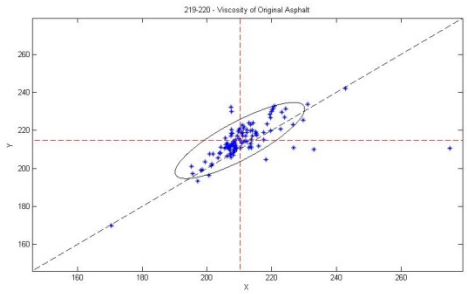

Figure C-8- PSP Sample 219-220

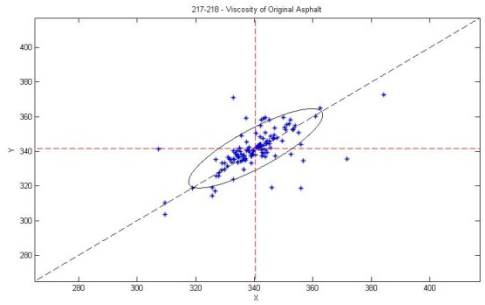

Figure C-9- PSP Sample 217-218

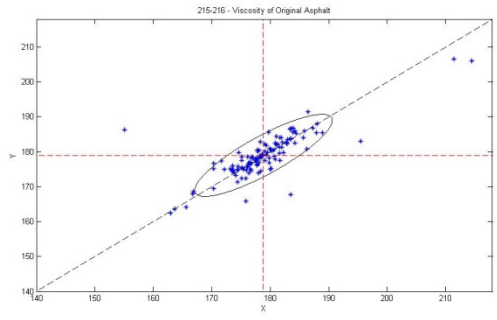

Figure C-10- PSP Sample 215-216

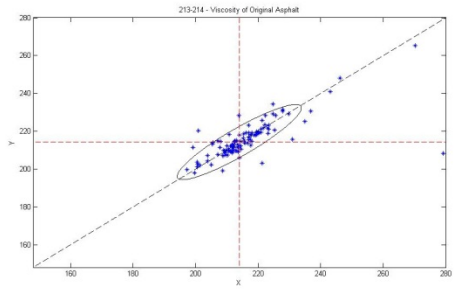

Figure C-11- PSP Sample 213-214

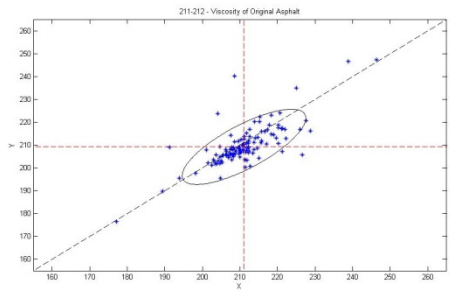

Figure C-12- PSP Sample 211-212

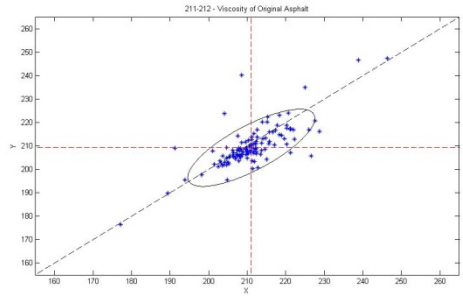

Figure C-13- PSP Sample 209-210

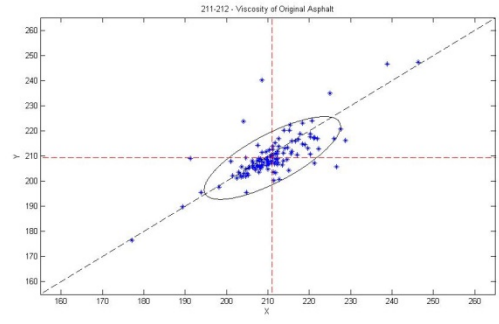

Figure C-14- PSP Sample 207-208

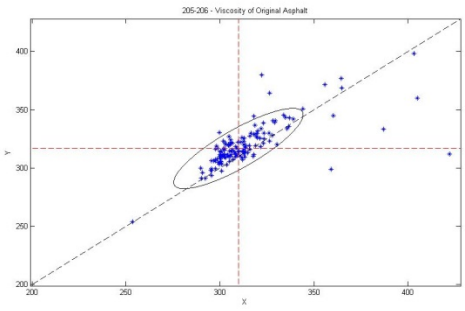

Figure C-15- PSP Sample 205-206

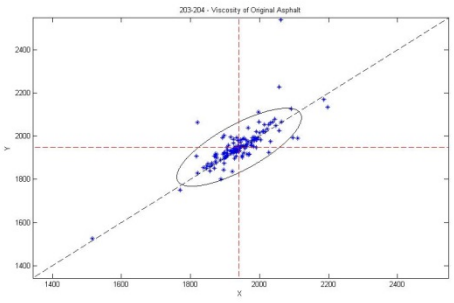

Figure C-16- PSP Sample 203-204

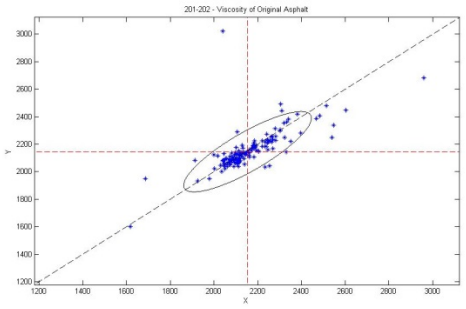

Figure C-17- PSP Sample 201-202

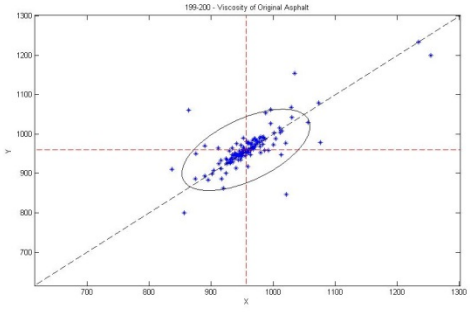

Figure C-18- PSP Sample 199-200

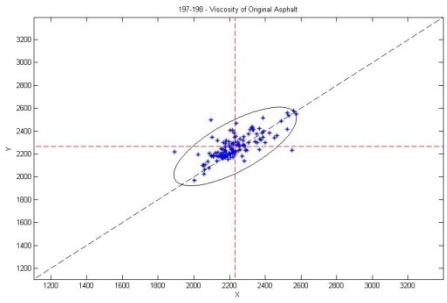

Figure C-19- PSP Sample 197-198

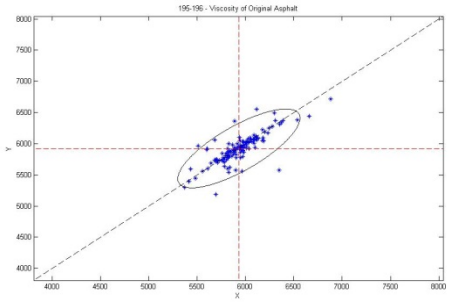

Figure C-20- PSP Sample 195-196

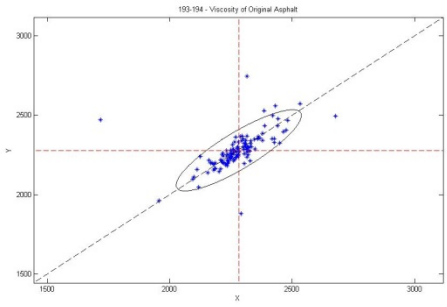

Figure C-21- PSP Sample 193-194

Viscosity of RTFO Asphalt Binder (T202)

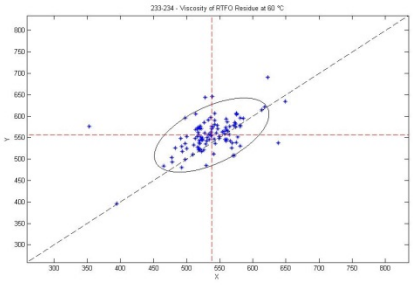

Figure C-22- PSP Sample 233-234

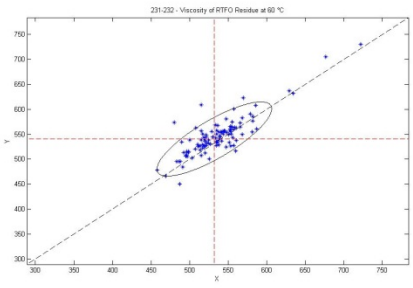

Figure C-23- PSP Sample 231-232

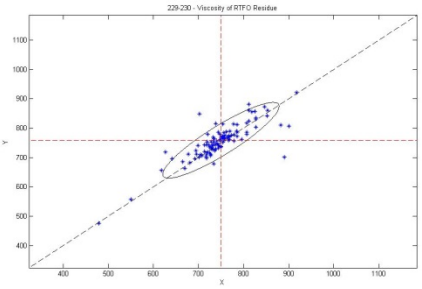

Figure C-24- PSP Sample 229-230

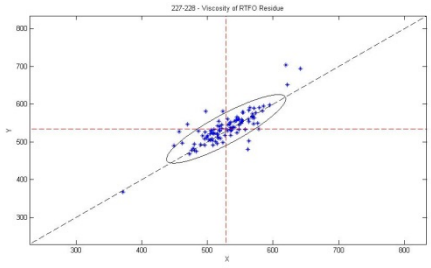

Figure C-25- PSP Sample 227-228

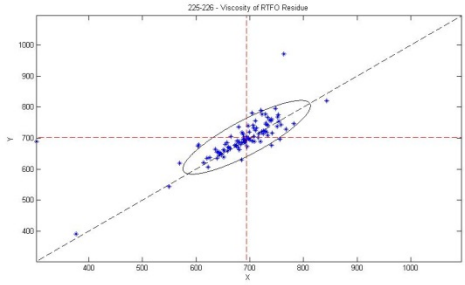

Figure C-26- PSP Sample 225-226

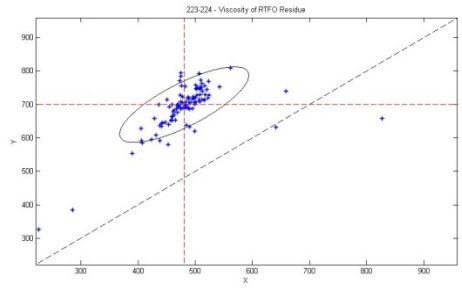

Figure C-27- PSP Sample 223-224

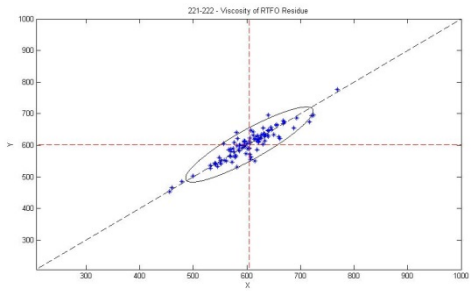

Figure C-28- PSP Sample 221-222

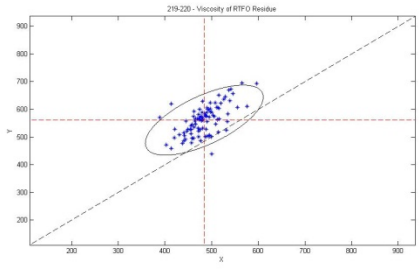

Figure C-29- PSP Sample 219-220

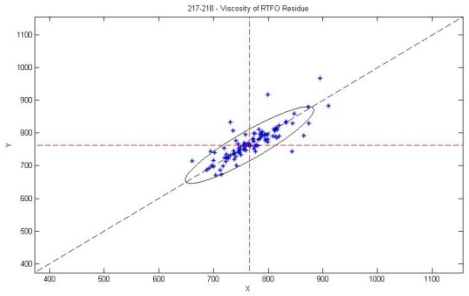

Figure C-30- PSP Sample 217-218

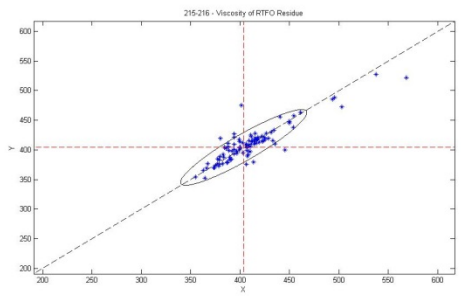

Figure C-31- PSP Sample 215-216

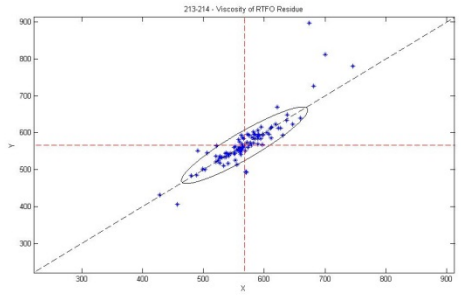

Figure C-32- PSP Sample 213-214

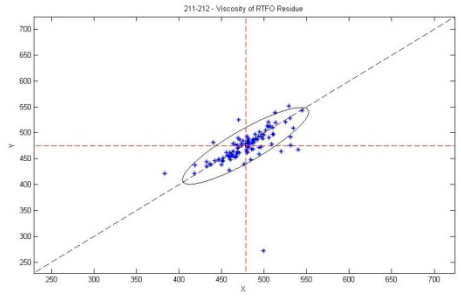

Figure C-33- PSP Sample 211-212

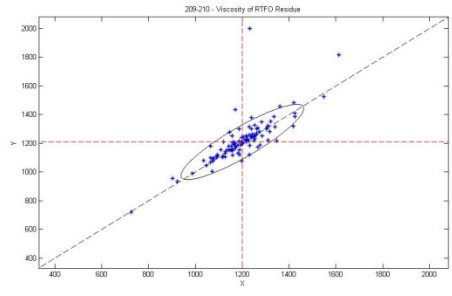

Figure C-34- PSP Sample 209-210

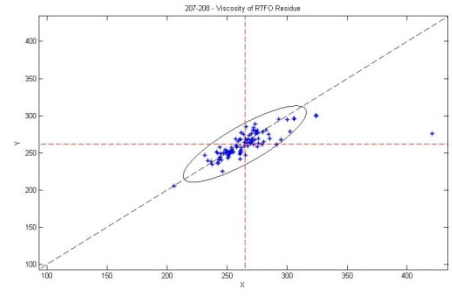

Figure C-35- PSP Sample 207-208

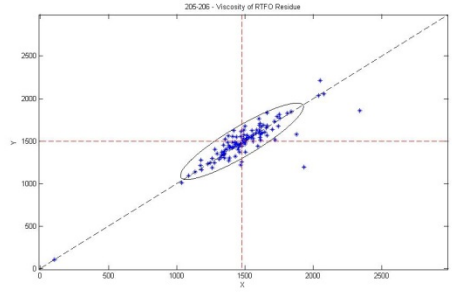

Figure C-36- PSP Sample 205-206

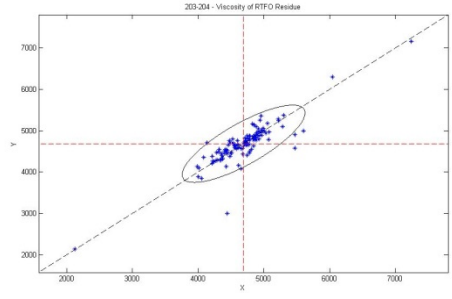

Figure C-37- PSP Sample 203-204

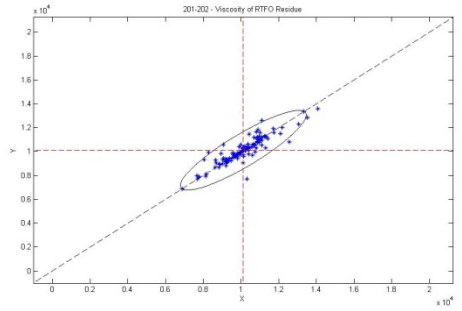

Figure C-38- PSP Sample 201-202

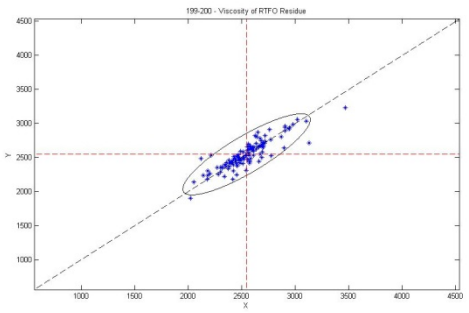

Figure C-39- PSP Sample 199-200

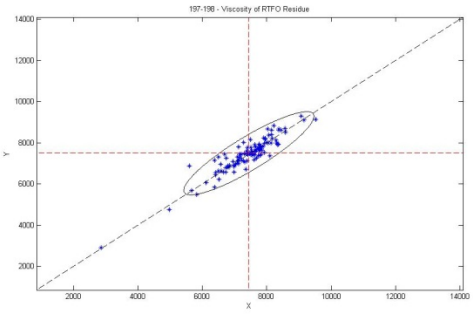

Figure C-40- PSP Sample 197-198

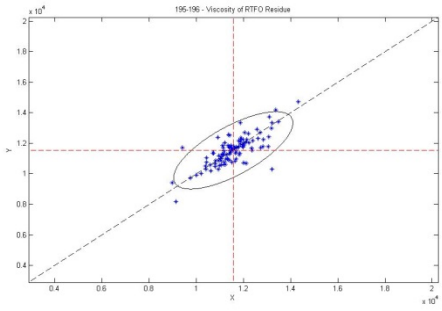

Figure C-41- PSP Sample 195-196

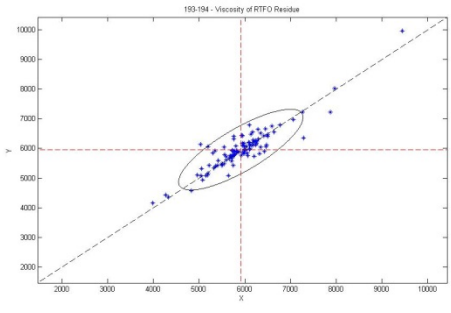

Figure C-42- PSP Sample 193-194

APPENDIX E- GRAPHS OF T 49 PROFICIENCY SAMPLE DATA

Penetration of Original Materials at 4°C (T49)

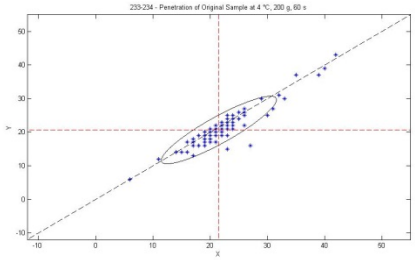

Figure D-1- PSP Sample 233-234

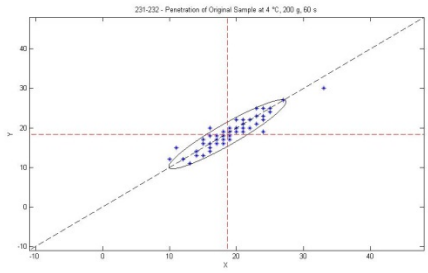

Figure D-2- PSP Sample 231-232

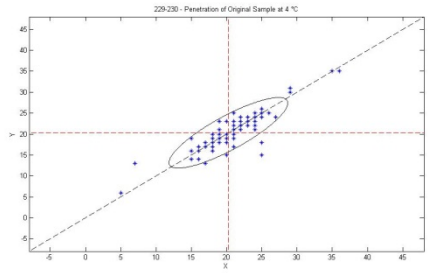

Figure D-3- PSP Sample 229-230

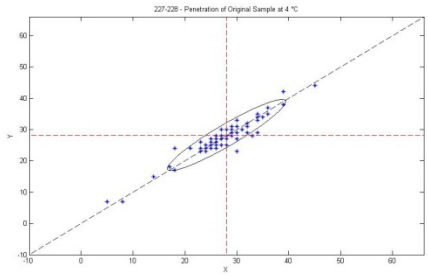

Figure D-4- PSP Sample 227-228

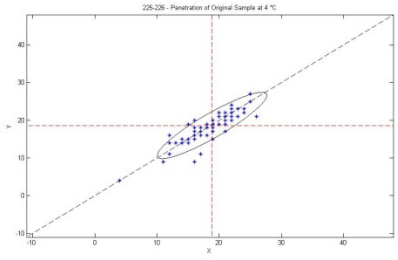

Figure D-5- PSP Sample 225-226

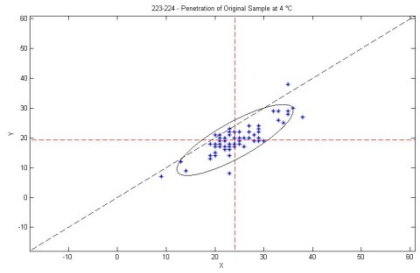

Figure D-6- PSP Sample 223-224

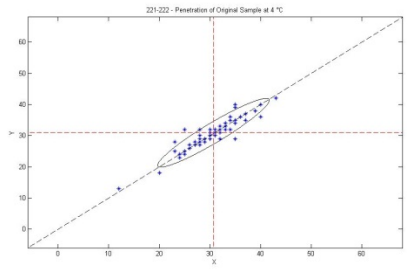

Figure D-7- PSP Sample 221-222

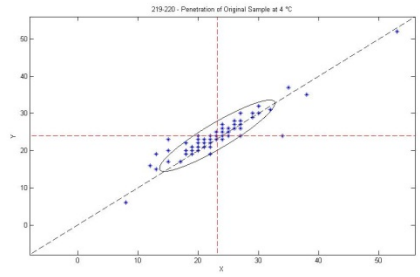

Figure D-8- PSP Sample 219-220

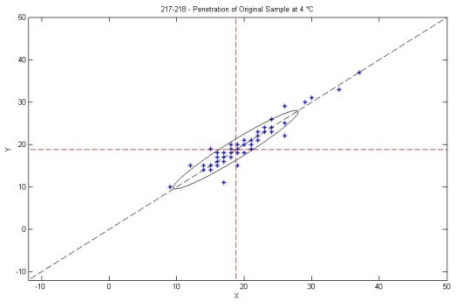

Figure D-9- PSP Sample 217-218

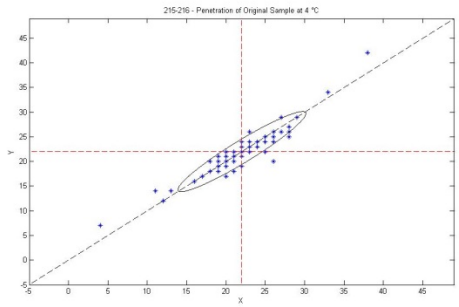

Figure D-10- PSP Sample 215-216

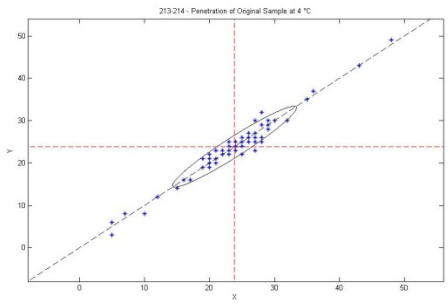

Figure D-11- PSP Sample 213-214

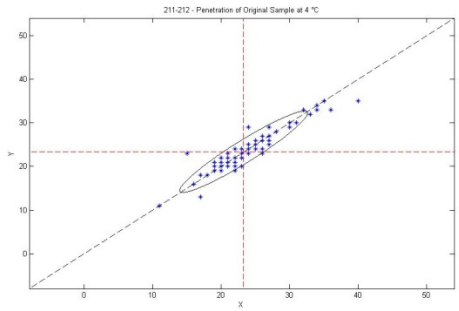

Figure D-12- PSP Sample 211-212

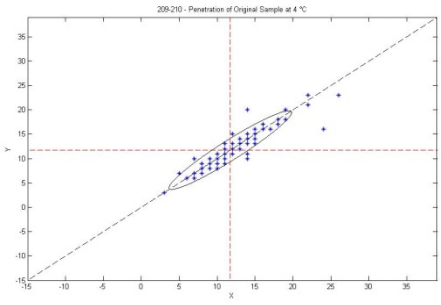

Figure D-13- PSP Sample 209-210

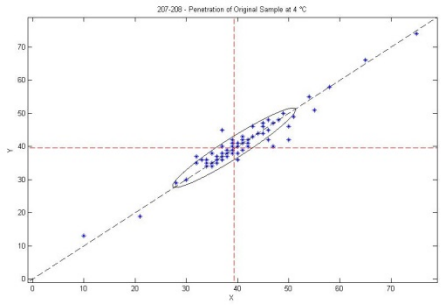

Figure D-14- PSP Sample 207-208

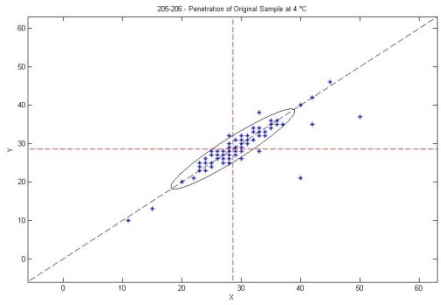

Figure D-15- PSP Sample 205-206

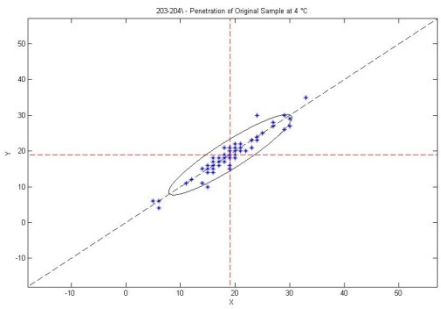

Figure D-16- PSP Sample 203-204

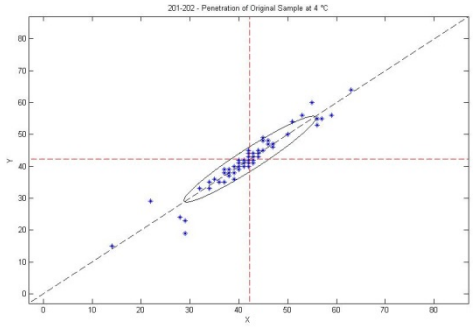

Figure D-17- PSP Sample 201-202

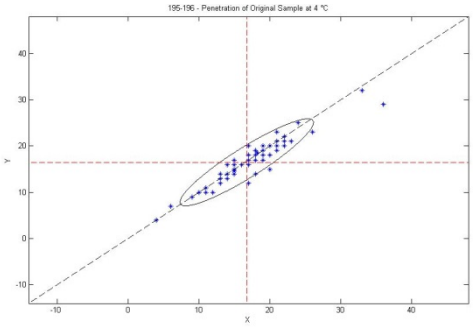

Figure D-20- PSP Sample 195-196

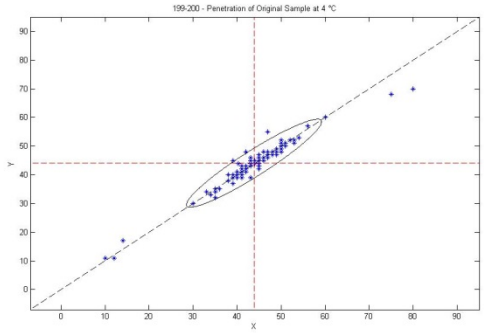

Figure D-18- PSP Sample 199-200

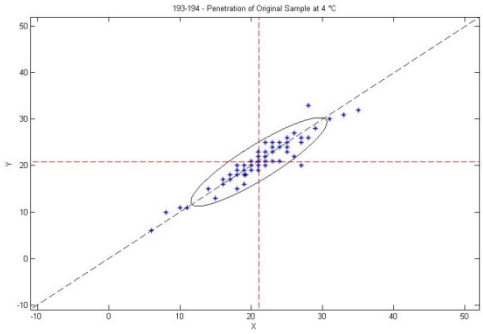

Figure D-21- PSP Sample 193-194

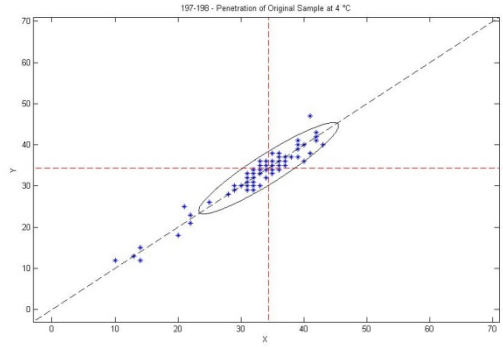

Figure D-19- PSP Sample 197-198

Penetration of Original Materials at 25°C (T49)

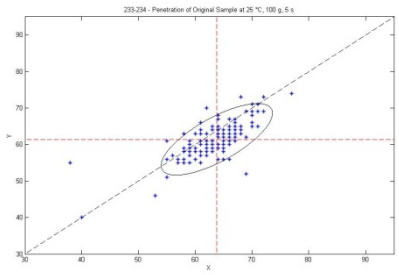

Figure D-22- PSP Sample 233-234

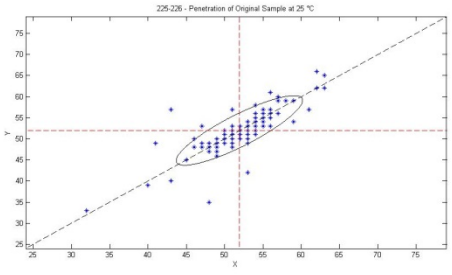

Figure D-26- PSP Sample 225-226

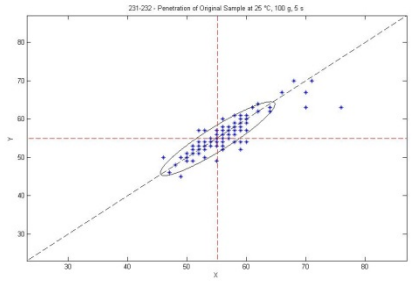

Figure D-23- PSP Sample 231-232

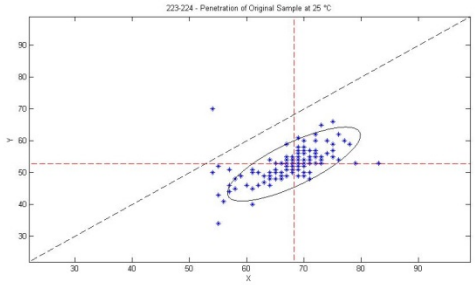

Figure D-27- PSP Sample 223-224

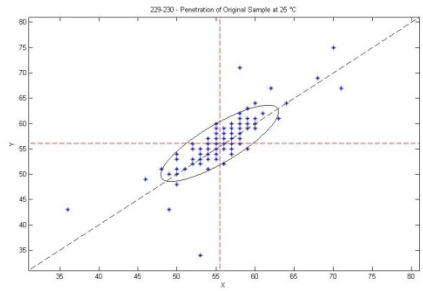

Figure D-24- PSP Sample 229-230

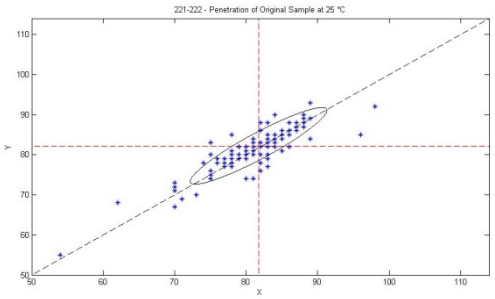

Figure D-28- PSP Sample 221-222

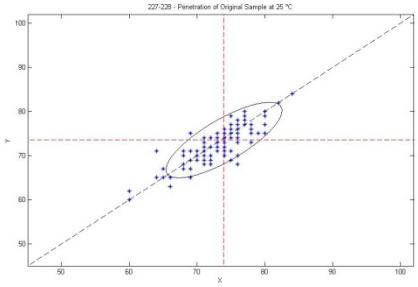

Figure D-25- PSP Sample 227-228

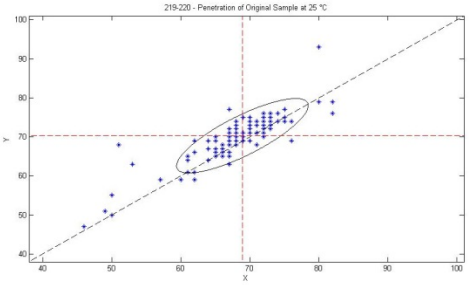

Figure D-29- PSP Sample 219-220

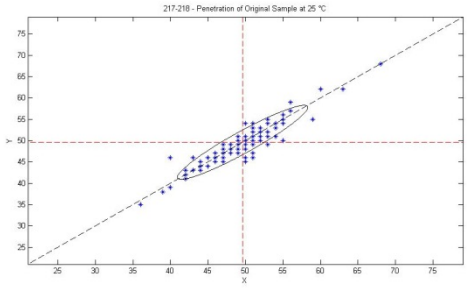

Figure D-30- PSP Sample 217-218

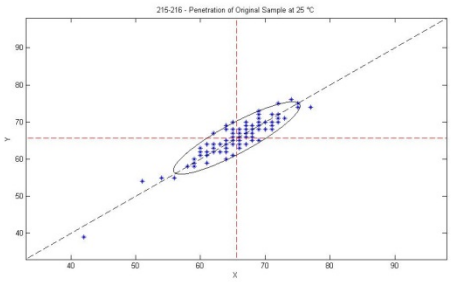

Figure D-31- PSP Sample 215-216

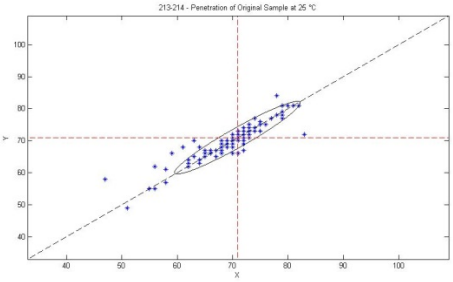

Figure D-32- PSP Sample 213-214

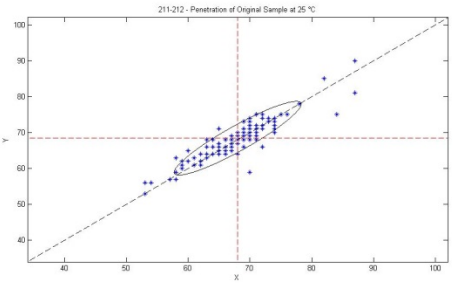

Figure D-33- PSP Sample 211-212

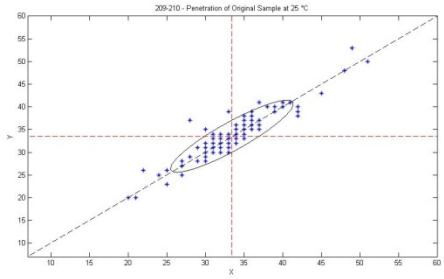

Figure D-34- PSP Sample 209-210

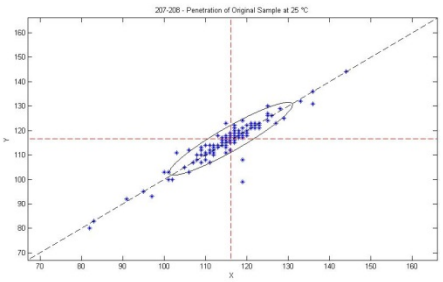

Figure D-35- PSP Sample 207-208

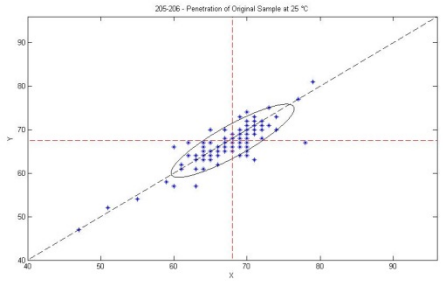

Figure D-36- PSP Sample 205-206

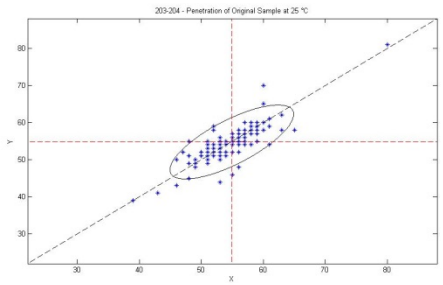

Figure D-37- PSP Sample 203-204

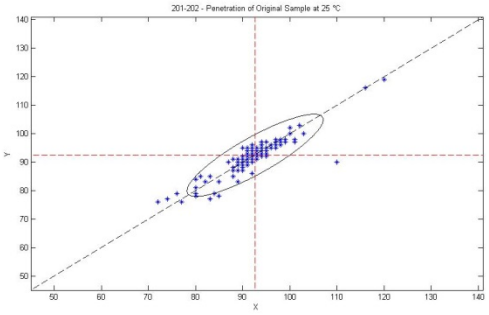

Figure D-38- PSP Sample 201-202

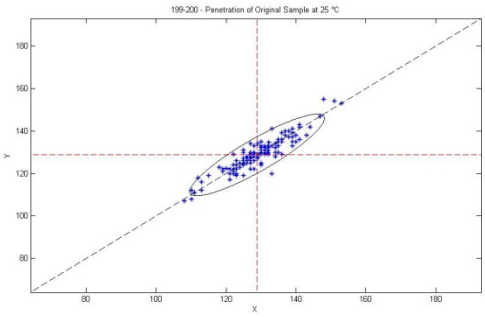

Figure D-39- PSP Sample 199-200

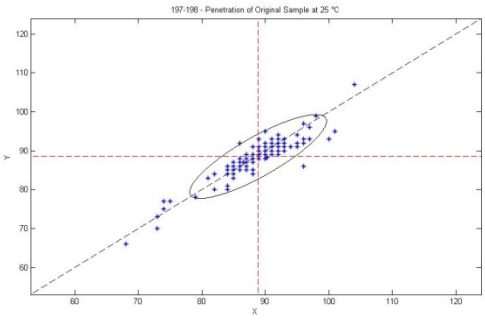

Figure D-40- PSP Sample 197-198

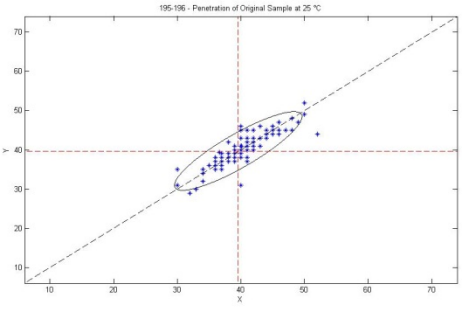

Figure D-41- PSP Sample 195-196

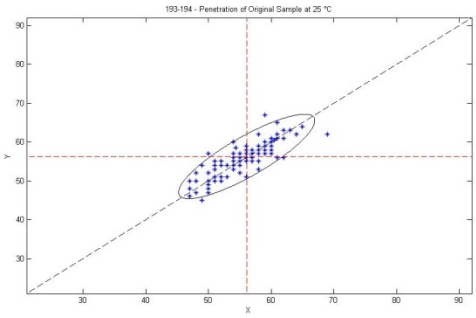

Figure D-42- PSP Sample 193-194

Penetration of RTFO Materials at 4°C (T49)

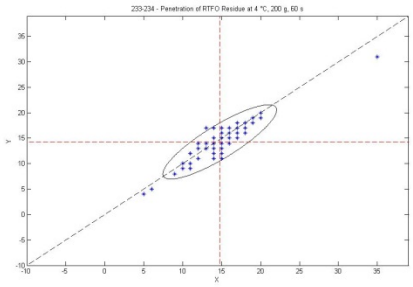

Figure D-43- PSP Sample 233-234

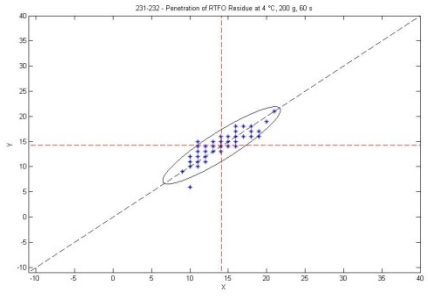

Figure D-44- PSP Sample 231-232

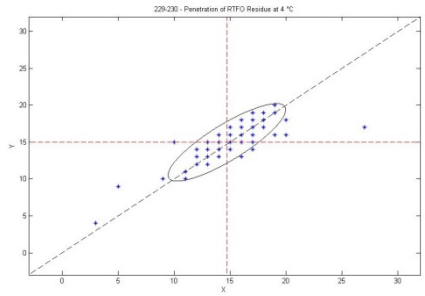

Figure D-45- PSP Sample 229-230

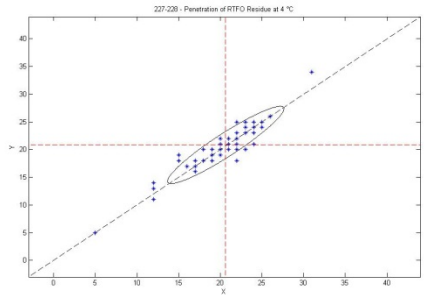

Figure D-46- PSP Sample 227-228

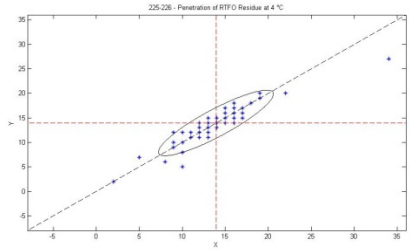

Figure D-47- PSP Sample 225-226

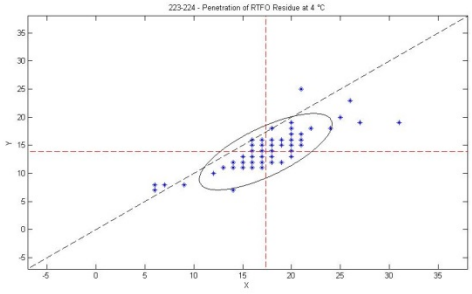

Figure D-48- PSP Sample 223-224

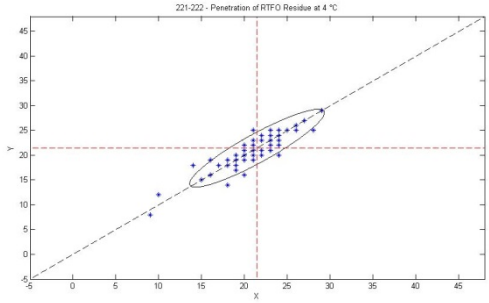

Figure D-49- PSP Sample 221-222

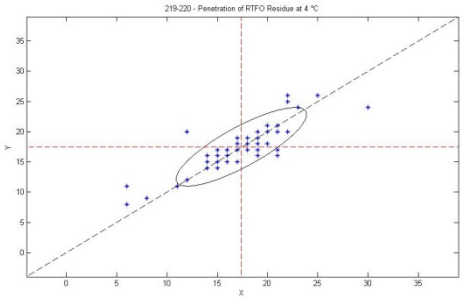

Figure D-50- PSP Sample 219-220

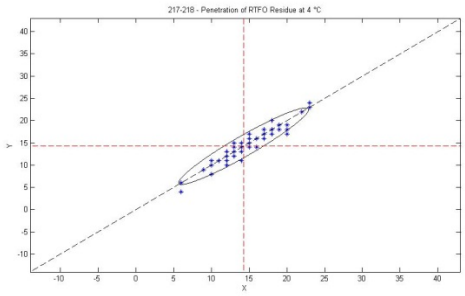

Figure D-51- PSP Sample 217-218

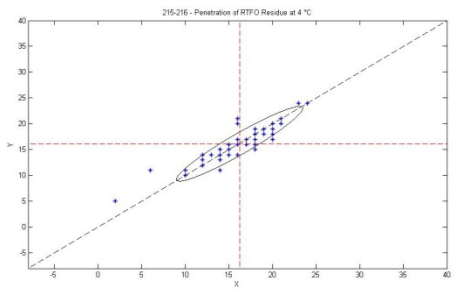

Figure D-52- PSP Sample 215-216

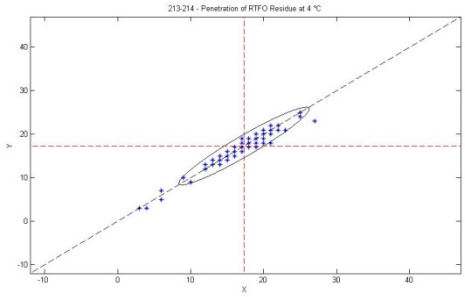

Figure D-53- PSP Sample 213-214

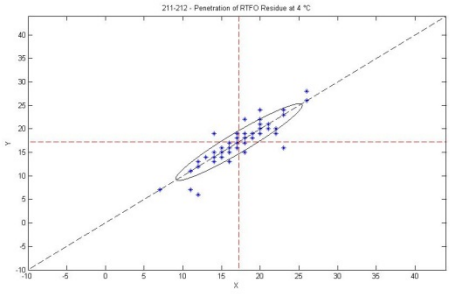

Figure D-54- PSP Sample 211-212

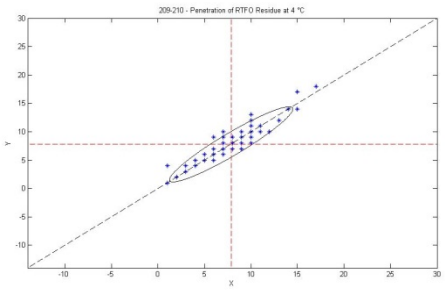

Figure D-55- PSP Sample 209-210

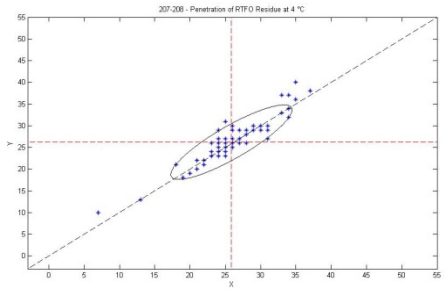

Figure D-56- PSP Sample 207-208

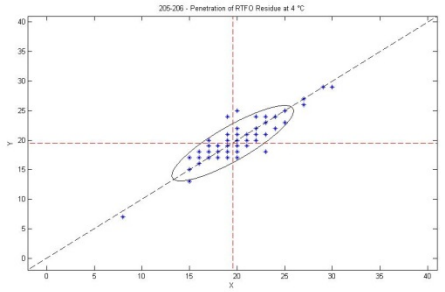

Figure D-57- PSP Sample 205-206

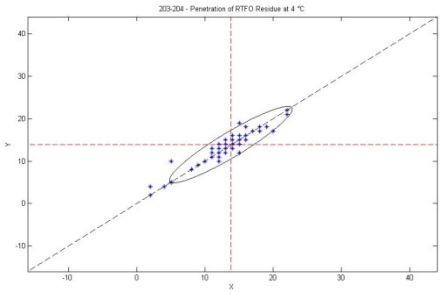

Figure D-58- PSP Sample 203-204

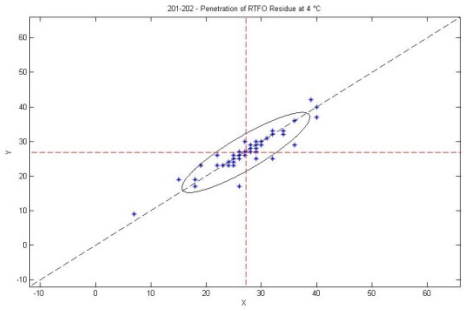

Figure D-59- PSP Sample 201-202

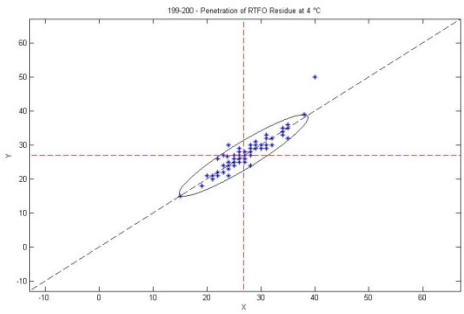

Figure D-60- PSP Sample 199-200

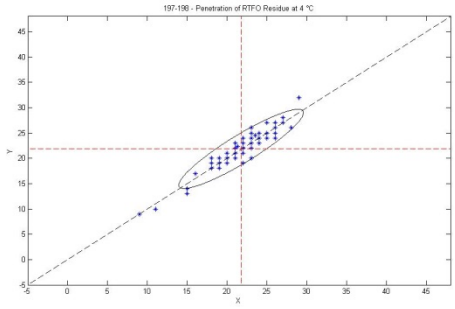

Figure D-61- PSP Sample 197-198

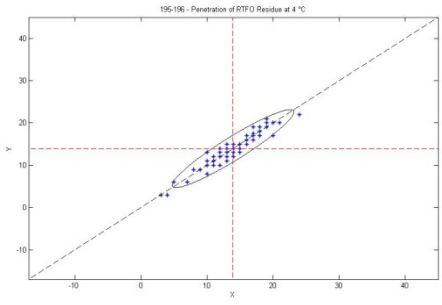

Figure D-62- PSP Sample 195-196

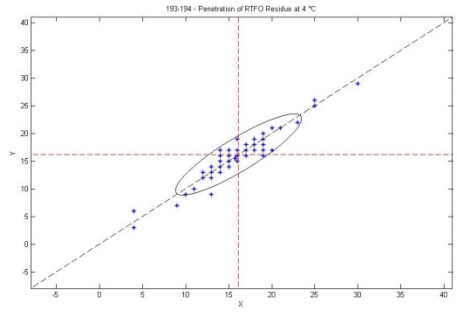

Figure D-63- PSP Sample 193-194

Penetration of RTFO Materials at 25°C (T49)

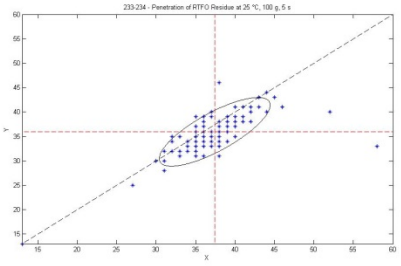

Figure D-64- PSP Sample 233-234

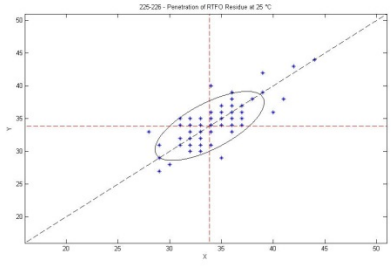

Figure D-68- PSP Sample 225-226

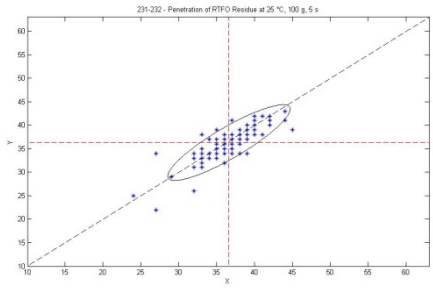

Figure D-65- PSP Sample 231-232

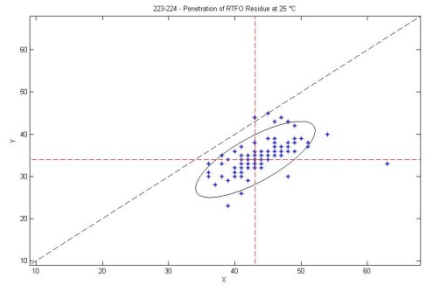

Figure D-69- PSP Sample 223-224

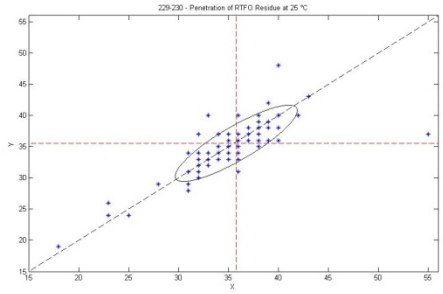

Figure D-66- PSP Sample 229-230

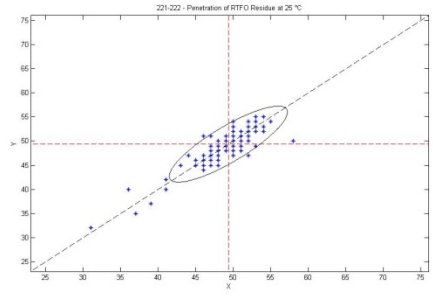

Figure D-70- PSP Sample 221-222

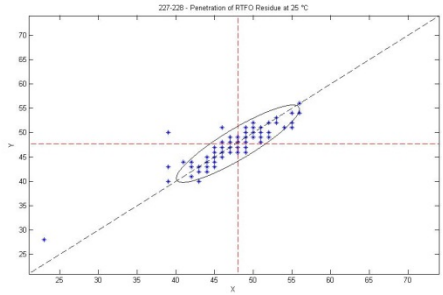

Figure D-67- PSP Sample 227-228

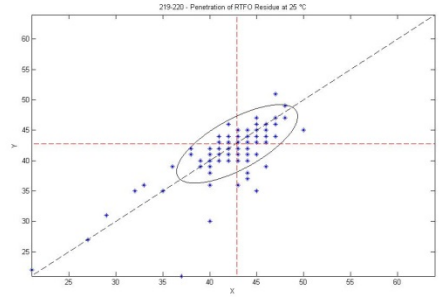

Figure D-71- PSP Sample 219-220

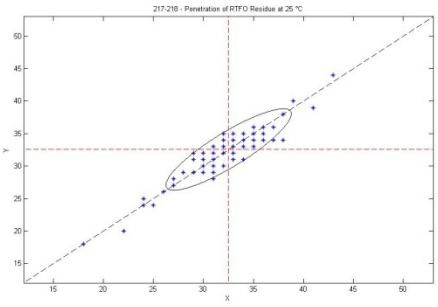

Figure D-72- PSP Sample 217-218

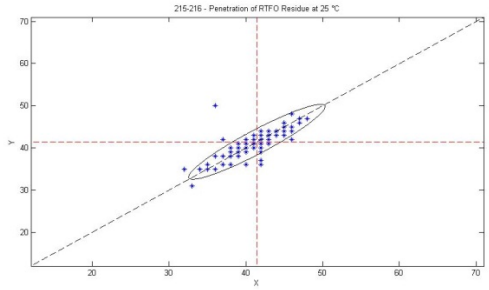

Figure D-73- PSP Sample 215-216

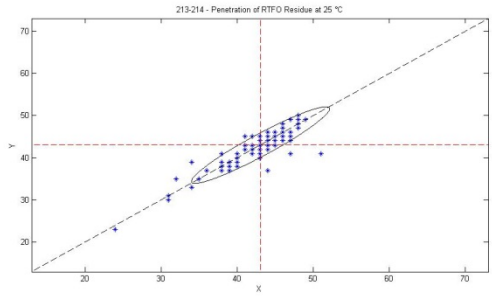

Figure D-74- PSP Sample 213-214

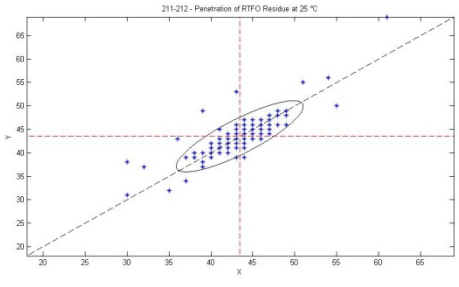

Figure D-75- PSP Sample 211-212

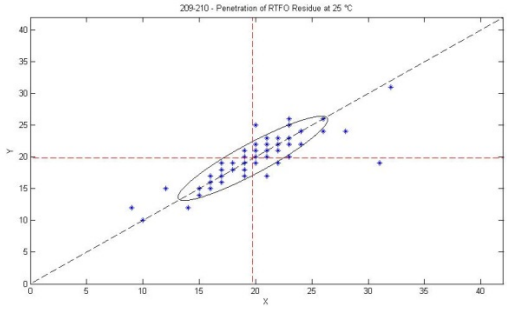

Figure D-76- PSP Sample 209-210

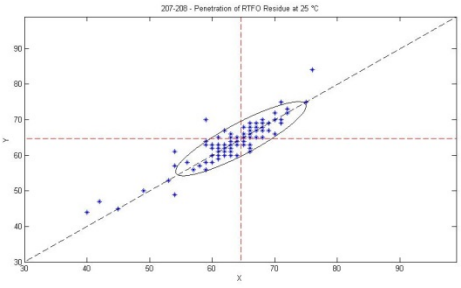

Figure D-77- PSP Sample 207-208

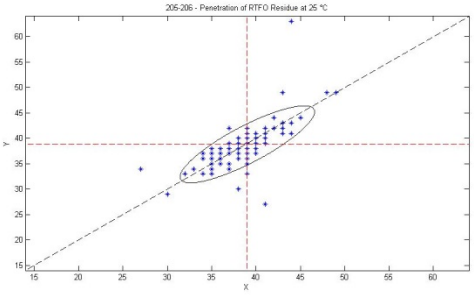

Figure D-78- PSP Sample 205-206

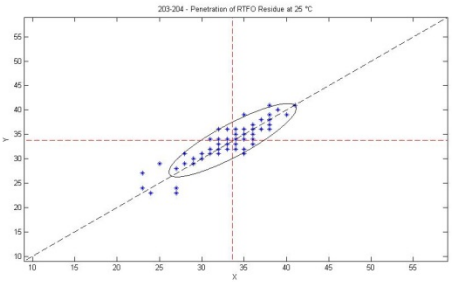

Figure D-79- PSP Sample 203-204

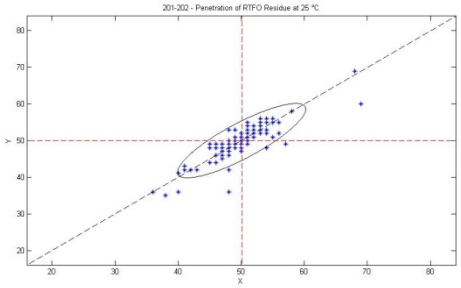

Figure D-80- PSP Sample 201-202

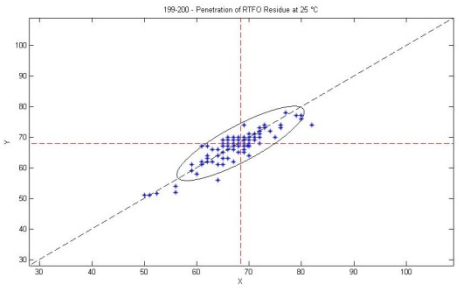

Figure D-81- PSP Sample 199-200

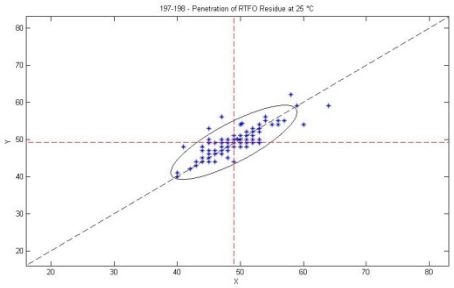

Figure D-82- PSP Sample 197-198

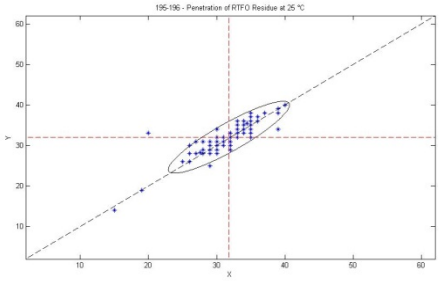

Figure D-83- PSP Sample 195-196

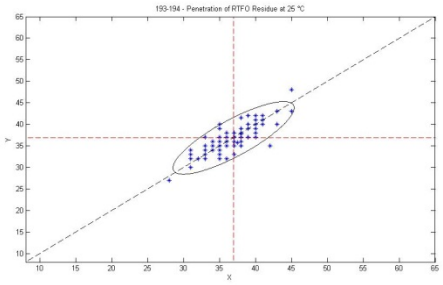

Figure D-84- PSP Sample 193-194

APPENDIX F- PRECISION STATEMENT FOR AASHTO T201

Kinematic Viscosity of Asphalts (Bitumens)

X. Precision and Bias

X.1. Precision

Criteria for judging the acceptability of kinematic viscosity of asphalt are given in Table X.

NOTE- The figures given in Column 2 are the coefficient of variation that has been found to be appropriate for the materials and conditions of test described in Column 1. The figures in Column 3 are the limits that should not be exceeded by the difference between the results of two properly conducted tests.

Table X – Precision Estimates of Kinematic Viscosity of Asphalts (Bitumens)

Condition of Test and Test Property	Coefficient of Variation (percent of mean) 1s%[a]	Acceptable Range of Two Test Results (Percent of Mean) d2s%[a]
Single-Operator Precision:		
Original	1.3	3.8
RTFO (Average of Kinematic Viscosity < 850 mm2/s)	1.5	4.2
RTFO (Average of Kinematic Viscosity ≥ 850 mm2/s)	2.7	7.6
Multilaboratory Precision:		
Original	2.3	6.6
RTFO (Average of Kinematic Viscosity < 850 mm2/s)	3.3	9.2
RTFO (Average of Kinematic Viscosity ≥ 850 mm2/s)	5.1	14.4

[a] These values represent the 1s % and d2s% limits described in ASTM Practice C670.

Note – The precision estimates given in Table X are based on the analysis of test results from 21 pairs of AMRL Viscosity Graded Asphalt Cement proficiency samples. The data analyzed consisted of results from 75 to 118 laboratories for each of the pairs of samples. The analysis included asphalt cements with the average kinematic viscosity of 283 mm^2/s to 702 mm^2/s for the original asphalt and 429 mm^2/s to 1,036 mm^2/s for the RTFO residue.

X.2. Bias

No information can be presented on the bias of the procedure because no comparison with the material having an accepted reference value was conducted.

APPENDIX G- PRECISION STATEMENT FOR AASHTO T202

Viscosity of Asphalts by Vacuum Capillary Viscometer

X. Precision and Bias

X.1. Precision

Criteria for judging the acceptability of kinematic viscosity of asphalt are given in Table X.

NOTE- The figures given in Column 2 are the coefficient of variation that have been found to be appropriate for the materials and conditions of test described in Column 1. The figures in Column 3 are the limits that should not be exceeded by the difference between the results of two properly conducted tests.

Table X – Precision Estimates of Viscosity of Asphalts by Vacuum Capillary Viscometer

Condition of Test and Test Property	Coefficient of Variation (Percent of Mean) 1s%[a]	Acceptable Range of Two Test Results (Percent of Mean) d2s%[a]
Single-Operator Precision:		
Original	1.5	4.2
RTFO	2.7	7.7
Multilaboratory Precision:		
Original	3.1	8.8
RTFO	6.8	19.2

[a] These values represent the 1s % and d2s% limits described in ASTM Practice C670.

Note – The precision estimates given in Table X are based on the analysis of test results from 21 pairs of AMRL Viscosity Graded Asphalt Cement proficiency samples. The data analyzed consisted of results from 94 to 135 laboratories for each of the pairs of samples. The analysis included asphalt cements with the average viscosity by vacuum capillary in a range of 102 Pa.s to 5,930 Pa.s for the original asphalt and 403 Pa.s to 11,585 Pa.s for the RTFO residue.

X.2. Bias

No information can be presented on the bias of the procedure because no comparison with the material having an accepted reference value was conducted.

APPENDIX H- PRECISION STATEMENT FOR AASHTO T49

Penetration of Bituminous Materials

X. Precision and Bias

X.1. Precision

Criteria for judging the acceptability of Penetration of Bituminous Materials are given in Table X.

NOTE- The figures given in Column 3 are the standard deviations that have been found to be appropriate for the materials and conditions of test described in Columns 1and 2. The figures in Column 4 are the limits that should not be exceeded by the difference between the results of two properly conducted tests.

Table X – Precision Estimates of Penetration of Bituminous Materials

Condition of Test and Test Property		Standard Deviation 1s[a,b]	Acceptable Range of Two Test Results d2s[a,b]
Single-Operator Precision:			
4°C	Original	1s = 0.01X + 0.8	1s = (0.01X + 0.8) x 2.83
	RTFO	1s = 0.02X + 0.4	1s = (0.03X + 0.3) x 2.83
25°C	Original	1s = 0.01X + 0.7	1s = (0.01X + 0.6) x 2.83
	RTFO	1s = 0.01X + 0.5	1s = (0.02X + 0.5) x 2.83
Multilaboratory Precision:			
4°C	Original	1s = 0.06X + 1.9	1s = (0.06X + 2.0) x 2.83
	RTFO	1s = 0.06X + 1.5	1s = (0.07X + 1.5) x 2.83
25°C	Original	1s = 0.03X + 1.3	1s = (0.02X + 1.8) x 2.83
	RTFO	1s = 0.04X + 1.2	1s = (0.04X + 1.2) x 2.83

[a] These values represent the 1s and d2s limits described in ASTM Practice C670.
[b] The value of X represents the average value of two test results

Note – The precision estimates given in Table X are based on the analysis of test results from 21 pairs of AMRL Viscosity Graded Asphalt Cement proficiency samples. The data analyzed consisted of results from 71 to 97 laboratories for each of the pairs of samples. The analysis included original asphalt cements with the average penetration value of 11.7 units to 44 units at 4ºC and 33.4 units to 128.9 units at 25ºC and RTFO residue with the average penetration value of 7.8 units to 27.2 units at 4ºC and 19.8 units to 68.4 units at 25ºC.

X.2. Bias

No information can be presented on the bias of the procedure because no comparison with the material having an accepted reference value was conducted.